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ABSTRACT

This survey of the literature provides a review and synthesis of research findings and current thought on the use of microcomputers by school children. Modes of learning and taxonomies of learning are described, and the results of recent surveys indicating the number of computers in schools and the amount of access by students are reported. Possible types of use are explored, including computer literacy, programming, subject specific uses, word processing, and organizational/thinking skills. Levels of sophistication of computer programs used in education are described, and the "hidden curriculum" of computer use is discussed, including cooperative use, male/female differences, intuitive learning, and attitude toward "right answers." Structured use of courseware is compared with uses of computers that may stimulate creativity. Thirty-three references are listed. (Author/LMM)

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# CHILDREN USING COMPUTERS: WHAT ARE THEY DOING? WHAT ARE THEY REALLY LEARNING?

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## ABSTRACT

Surveys literature which examines use of microcomputers by school children. Modes of learning and taxonomies of learning are described. Results of recent surveys indicating the number of computers in schools and the amount of access by students are reported. Possible types of use are explored, including computer literacy, programming, subject specific uses, word processing, and organizational/thinking skills. Levels of sophistication of computer programs used in education are described. Discusses the "hidden curriculum" of computer use, including cooperative use, male/female differences, intuitive learning, and attitude toward "right answers." Structured use of courseware is compared with uses of computers which may stimulate creativity.

## INTRODUCTION

This paper provides a review and synthesis from many sources, including books, articles, research reports, and industry reviews and commentary, in order to draw conclusions and make assumptions based upon existing literature.

Children are using microcomputers not only in schools, but in homes, libraries, computer camps and even nursery schools. Soon they may be learning in nationally franchised computer learning centers (11). The arguments for including computers as a tool for learning are often expressed as some variant of the following:

1. Computers are a "good thing" for educating children--and even if computers might be a "bad thing"-- it is necessary for students to be exposed to them.

2. Other children use computers in school--our children must use computers in school.

The assumption, of course, is that with the computers in the schools, learning will be improved. What children actually learn via computer in a given school is based upon a variety of factors: the number of microcomputers available for their use; the type of planning done and objectives set by parents and educators; and the type of software

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available for their use. This paper does not intend to address how well children learn with computer based instruction compared to other means of instruction, (although several major reviews of research indicate that computer based instruction (CBI) can be effective in raising test scores of students and may also considerably shorten the time required for instruction) (5) (17). Rather, it will examine the manner in which children are learning, time spent with computers, and what is being learned aside from subject content.

MODES OF LEARNING

One way of looking at how children may be learning through computers is to examine the major modes of learning with computer software. The principal modes for learning via microcomputer include the following:

Tutorial: New material is introduced. The program delivers the instruction to the student.

Drill and practice: Instruction has already taken place. Students are provided with opportunity for repeated practice. Feedback is immediate. Some programs provide progress reports for teachers and/or students.

Simulations: New material is learned through taking part in representations of activities or processes. Students make decisions and see the consequences of their choices without suffering real-life penalties.

Problem-solving: Students analyze a problem and develop a solution.

Games: Students compete against self or others. They must develop strategies and follow stated rules.

TAXONOMIES OF LEVELS OF LEARNING:

The taxonomies of levels of learning developed by Bloom and Krathwohl as a means of classifying educational objectives provide another way of looking at how children may learn with computers. Each domain of learning--psychomotor, affective, and cognitive--has several levels, arranged more or less in order of increasing complexity. Only the affective and cognitive taxonomies will be listed here:

AFFECTIVE LEARNING:

Receiving: Being aware of and willing to pay attention to a stimulus.

Responding: Actively participating, reacting in some way.

Valuing: Voluntarily displaying an attitude, showing an interest.

Characterization: Demonstrating an internally consistent value system, developing a characteristic "life style" based upon a value or value system.

COGNITIVE LEARNING:

Knowledge: Recalling specifics, remembering, defining, recognizing, repeating.

Comprehension: Translating, interpreting, paraphrasing, summarizing, extrapolating.

Application: Using ideas and information.

Analysis: Recognizing and distinguishing elements and their relationships to each other.

Synthesis: Combining components so as to form a new whole.

Evaluation: Using standards of appraisal to make judgements for given purposes. (6)

Descriptions of children using computers almost always comment on the affective domain of learning. Affective learning is widely mentioned in reports and articles even when the subject under discussion deals with cognitive learning via computer. Children want to use computers in learning and apparently enjoy learning with computers. This has prompted some adults to express fear that students will become so enamoured of computer learning that they will become "hackers," and prefer interacting with machines rather than with people. At the present time, most children do not have sufficient access to computers to make this a matter for general alarm.

While there is less agreement and less direct comment regarding cognitive learning via computer it is clear from examination of computer software, software reviews, industry reports and articles in educational journals, that much educational computer software has concentrated on the lower levels of the taxonomy such as recall and recognition, rather than upon the higher levels of analysis, synthesis and evaluation.

NUMBER OF COMPUTERS IN SCHOOLS

Schools have been acquiring computers, and particularly microcomputers, at a rapid rate. The first nationwide survey of school districts about their uses of computer technology was undertaken by Educational Research Service in 1980-81 and included all types of computers and computer

applications. At that time, two-thirds of school districts reported the existence of some sort of computer literacy program; however, computer assisted instruction (CAI) was used in only 56.5% of the responding districts. (25)

In the summer of 1983, a survey of all 15,275 school districts in the United States revealed that:

> Only 14% of U.S. school districts do not use computers.
>
> 68% of all schools have computers of their own: 62% of elementary schools; 81% of junior high schools; 86% of senior high schools;
>
> 55,765 public schools used computers in instruction, double the number reported the previous year;
>
> 31,069 schools began using computers during the past year, more than in all prior years combined;
>
> The number of computers per school varies with level: the average high school had 11 computers; the average junior high school had 7; the average elementary school has 35:
>
> There were at the time of the survey, 325,000 microcomputers in U.S. public schools: 110,000 in elementary schools, 55,000 in junior high schools; 135,000 in senior high schools; the balance in K-12 systems and special education schools. (18) (22)

An industry study conducted by Knowledge Industry Publications, Microcomputer Hardware and Software in the El-Hi Market, 1983-87, indicated that by the end of 1983, 400,000 microcomputers were in use in elementary and secondary schools in the United States. In 1983, United States elementary and secondary schools made microcomputer related purchases amounting to $488 million; $38 million of this amount was spent for software. Eighty-seven percent of the computers purchased by schools in 1983 were produced by Apple, Radio Shack and Commodore. (19) (20)

AMOUNT OF USE:

The National Survey of School Uses of Microcomputers conducted by the Center for Social Organization of Schools at The Johns Hopkins University (10) indicated that the time students spend learning via computer is minimal:

> In the schools with computers, about one student in seven actually uses one during any given week.
>
> The average elementary school student gets less than 25 minutes of computer use per week; one third get less than 15 minutes per week.

> Elementary school students use computers for computer literacy and writing programs (19 minutes per week), drills and remedial work (13 minutes) and learning games (12 minutes).
>
> Secondary school students write programs (55 minutes per week), do drill and remedial work (17 minutes) and use learning games (11 minutes).
>
> Most students do not have an opportunity to use computers for word processing or science laboratory work; when they do, on the average they get 30 minutes per week, although a third of the students may spend more than an hour per week on these activities. (2)

TYPES OF USE:

Schools could use computers to teach computer literacy, teach programming, teach or supplement instruction in specific subjects, teach word processing as an individual subject or use it for developing writing skills, or use software to develop or structure organizational and thinking skills. What types of use do schools make of computers? Computer literacy, programming, and teaching specific subject material are most common, word processing is being used to varying degrees and materials on "thinking skills" are just entering the picture.

Computer literacy

Computer literacy is a term with varied meanings. Literacy may include knowing how computers work, knowing what computers can do, being able to use commercially available software of one sort or another, being able to program computers in one or more languages, or any combination of the above. Much instruction that is subject specific probably comes under the category of computer literacy due to the limited amount of time the student actually has with the computer.

Programming

At the high school level, the primary use of computers is for programming. Elementary schools are using LOGO in one of its many versions for teaching programming techniques to very young children. Many questions remain to be answered. Should a definition of computer literacy include knowledge of how to program? How much programming is needed? What languages should be taught/learned? Does programming sharpen the mind any more or any differently than traditional learning of subjects such as geometry or a foreign language?

Subject Specific

It is difficult to determine the amount of subject specific use of com-

puters by children in schools. Textbook publishers have jumped on the bandwagon and are providing educational software (often called "courseware") coordinated with their printed textbook series. Increasing efforts are being made to develop tools for identifying courseware (27) and evaluating it. (1) (28) However at the present time, there is more attention devoted to where to find and how to evaluate software than information on what is being purchased, let alone what is actually being used in schools. We do know that materials have been developed in all areas of curriculum, from mathematics, chemistry, and physics, to economics, reading readiness, and typing. The Northwest Regional Educational Laboratory has developed an online database devoted to computer applications in education, called Resources in Computer Education, (RICE). RICE entries include subject curriculum guides and implementation reports.

Word Processing

Word processing is being used in schools, but probably not as much as many would like. The Writing to Read Program (33), uses writing on computers to enhance the teaching of reading, allowing very young children to write anything they can say. Bank Street Writer is an easy-to-use word processing program which is being used by young children in many schools. Teachers report improved products and changes in attitudes towards revision of written work when word processing is used, as it allows children to correct errors and revise their work more easily. However, word processing is a time-consuming use of computers and its use may remain limited in some schools due to the need to share equipment.

Organizational/Thinking Skills

This category includes programs such as database management, time management or scheduling software, and programs specifically developed to "improve thinking skills." There is no indication that students are using database management or time management programs outside of business related courses. Programs designed to improve thinking skills are very new. Articles seem to be primarily directed towards promotion of use of this type of software, rather than reports of actual use.

LEVELS OF SOPHISTICATION

The following three levels are offered as an attempt to classify programs as to their sophistication. Level One software would be that which recreates the printed workbook on the computer screen. These programs are primarily drill and practice and tutorial in nature. They are set at the recall/recognition levels of cognitive learning. Poor programs of this type were described by Education Secretary Terrel Bell as, "electronic-page turning." (9) (31)

Level Two software uses the capabilities of the computer more fully by

providing for more individualization and interactivity. This level has branching capabilities which let individual users proceed in different ways through the program. These programs may make imaginative use of graphics to get their message across. Level Two software includes game or simulation formats as well as tutorials and drill and practice. These programs require the higher level skills of comprehension and application in addition to recall and recognition.

Level Three is also interactive and provides content in imaginative ways, but in addition to the content provided at the surface level, Level Three software provides for intuitive learning or encourages problem solving in ways not possible with other types of media. This may occur within a game format or through learning a programming language such as LOGO. Programs such as Electronic Arts', The Music Construction Set, or Rocky's Boots by The Learning Company, encourage or require higher level learning such as analysis, synthesis and evaluation. Seymour Papert, (24) developer of LOGO, points out that children who are programming are also learning to think about thinking.

## HIDDEN CURRICULUM

The use of computers also has what I like to call a "hidden curriculum." The hidden curriculum consists of attitudes, assumptions, skills and techniques which are part of the baggage that goes along with using computers for educational purposes. It includes such things as cooperative learning, male/female differences in attitudes toward computers, attention to detail, intuitive learning, and finding alternative paths to "right answers."

### Cooperation

What are children learning through computers at the present time? They are definitely learning to cooperate and share equipment. Despite the increased purchases of microcomputers, very little of their instructional time is spent learning from computers. Schools are devising new ways to get the most learning time from a limited number of computers. A method called Peer Tutoring which involves students teaching other students how to program is being developed and tested by a non-profit organization called Interactive Sciences, Inc. of Palo Alto, CA. (29) Some courseware producers are designing programs meant to be used by children in pairs or small groups.

### Male/Female Differences

Boys and girls view computers differently. The differences become more marked in the upper grades. These differences in male and female use of computers apparently reflect similar differences in male and female participation in elective math and science courses. A typical headline asks, "Why is the World of Computers Dominated by Males?" (30). Among

the reasons suggested for the lack of interest by girls: few female role models as teachers; TV ads which feature boys rather than girls; parents who buy computers for boys, but not girls; shoot-em-up software games which tend to attract males rather than females. Some software firms have begun to design and advertise software intended to attract girls. (15) Peer tutoring is said to be helpful in getting girls interested in computing as the learning takes place in a social interactive situation with girls helping girls. (29)

Attention to Detail

Anyone using microcomputer programs, no matter how "user friendly," soon learns that computers do exactly what you tell them to do rather than what you intend. This does encourage attention to detail and is given as one possible reason why some children gain more from CBI than others. Game players frequently comment on the need to pay attention. One player said, "I play computer games because they improve my concentration ... You are rewarded for paying attention to detail and penalized for ' dlesness." (32)

Intuitive Learning

There is increasing commentary on intuitive learning which may occur with software of the kind I have called Level Three. Reviewers are commenting on intuitive learning as they discuss simulations, game programs and text adventures. Many educators have viewed game programs with suspicion, particularly if they resemble too closely those found in video arcades. Educational writers are beginning to defend the use of selected game programs and to encourage their use in learning, in part because of the intuitive aspects of the better programs.

Alternate Paths to Right Answers

How is learning changed if there are several "right answers" or one "right answer" which can be arrived at from several directions? The task of "debugging," or identifying and correcting errors, is inescapable in computer programming. Schooling often emphasizes getting "the" right answer, and considers an inability to get the right answer on the first try as a failure. In programming, there is an expectation that there will be things wrong with the programs a person writes, that programs will have to be "debugged" or fixed, and that it is possible and desirable to do so. There is often an expectation that the "right" answer can be arrived at from different directions, using a variety of methods rather than only one "correct" method. How does the task of learning change if the emphasis is on continued problem solving rather than getting one "right" answer?"

ALTERNATE PATHS IN COMPUTER AIDED INSTRUCTION

There are two patterns in CAI; one is very clear and the other is

there, but not as immediately evident. The clear pattern is that of providing increased funding for computer aided instruction, more structure in planning, and more careful selection of "high quality" courseware. The other trend is less organized, and is at this point less a pattern than a set of ideas advocated by individuals who see experimentation and free play as more desirable learning experiences than the more structured learning provided by curriculum related courseware. There are also a few individuals who advocate student use of working world software tools rather than courseware. (7) (8) (12)

On the state level, California, West Virginia and Florida have set aside substantial funds for computer education. The Minnesota Legislature has mandated a planning process for schools wishing to receive funds allocated through the $5.8 million Minnesota Technology and Educational Improvement Act. Its purpose is to assist Minnesota schools in developing plans, training staff and identifying and purchasing quality software. (21)

The National Institute of Education is undertaking research and development plans on education and technology. (16) The Agency for Instructional Television plans to expand its mission to include development of instructional materials using not only television but also computers. (3) An offshoot of the Children's Television Workshop called the Children's Computer Workshop is now involved in software design. And with more educational dollars available for computer based education, textbook publishers are also moving into dvdelopment of courseware. Textbook publishers tend to be cautious and conservative. They look at marketing strategies and publish new textbooks that are very much like existing successful textbooks. Will this also be true for software? Are these publishers likely to be truly innovative in their software? Will profit margins and sales goal coincide with educational effectiveness?

Would educators purchase and use innovative products or choose materials similar to those they are familiar with in other media? Computer use is determined by teachers and adminstrators as is instruction in general. According to a recent study of classroom teaching, most learning takes place at low levels of the taxonomies of learning. The seven year study involving more than 1000 classrooms indicated that in most schools, the emphasis is upon recalling information. Subject matter emphasizes facts rather than concepts. Teachers rarely encourage discussion among students and students get few opportunities to plan their own learning, make choices or solve problems. (14) Classroom teachers will be making decisions on the purchase and use of software in schools. How innovative will they be? Many schools are developing selection procedures in which an examination committee makes decisions on what software to purchase. How innovative are committees likely to be?

Let's look at an alternate pattern which could emerge if there is less structure, less emphasis on "the basics," and less use of courseware

designed to teach what schools have been teaching with textbooks. It is not as familiar, but it has enormous potential. This pattern would provide "real applications" software for student use; it would allow students to learn by "messing around" rather than by structuring experiences to teach existing curriculum. This would mean encouraging independent student-centered discovery learning. Somehow children learn to process incredible amounts of information and gain all sorts of knowledge in an unstructured way up to the age of five. Most of them do this with great zest and enthusiasm. Shortly after they enter educational institutions we stop expecting them to be successful independent learners and they are very quick to live up to our expectations. What might happen if we provided children with computers, time to use them, and an assortment of software, not necessarily of the courseware variety? What would happen if they did not have to learn what teachers wanted them to learn, but could use the computers during this time to pursue their own interests with assistance from "coaches"?

These questions are prompted by reading done simultaneously in the areas of creativity and computers in education. It is interesting to read reports of people of all ages playing adventure games, solving a simulation game, programming computers because they want to. It is also interesting to read about creative individuals (4) (26) and creative problem solving. (23) But what is fascinating is to note the words which appear over and over in both types of literature. Words describing sensitivity to problems, flexibility in exploring possibilities, originality, curiosity, motivation, intuition, persistence, concentration, and freedom to fail. Will these same words appear in accounts describing use of courseware? Is using even good courseware the best way to assist student learning? If computer aided education is effective in helping children to learn through practice of "basic skills" will this type of use crowd out other possible uses? We need to ask these questions now, before we become so locked into using computers for raising test scores that we forget how they could be creatively used in educating children for the future.

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